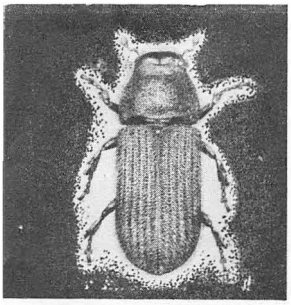
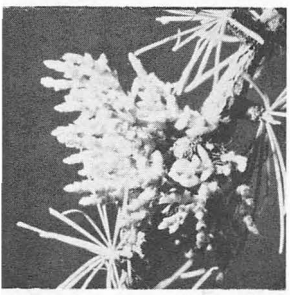
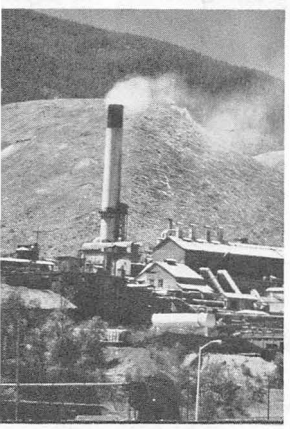
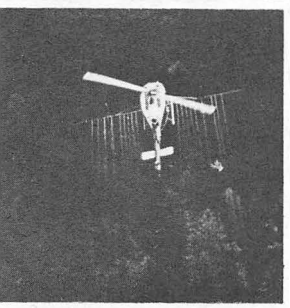
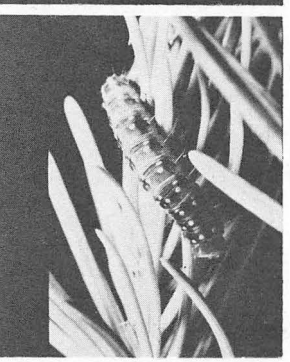
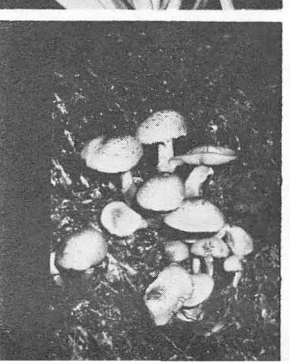

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FOREST INSECT & DISEASE MANAGEMENT

USDA · FOREST SERVICE · NORTHERN REGION

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Report No. 77-4

5200
February 1977

STATUS OF MOUNTAIN PINE BEETLE INFESTATION GLACIER NATIONAL PARK, 1976

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ABSTRACT

Mountain pine beetle populations began increasing in Glacier National Park in 1970. Numbers of infested trees increased steadily from an average of 12 to 115 per hectare from 1972 to 1976. Total hectares of infestation have increased from 445 in 1972 to 40,419 ha in 1976. Predictive equations estimate a cumulative loss of nearly 3 million trees by 1977. Silvicultural practices to reduce the phloem thickness/tree diameter distribution in stands are the best known management alternatives. But because of the National Park Service policy to permit mortality as part of natural succession, application of these alternatives is not recommended.

INTRODUCTION

Mountain pine beetle, *Dendroctonus ponderosae* Hopk., has caused extensive tree mortality in Glacier National Park over the last 25 years. The last reported outbreak began in the northwest corner of the Park on Starvation Ridge near Kintla Lake in 1950 (Tunnock 1970). Approximately 7,960 trees were killed during that infestation. Number of infested trees declined to 2 trees per ha in 1959 and remained static until 1970. In 1970, an increase in "faders" was detected through aerial surveys. Epicenters were detected at Starvation and Quartz Ridges. Since 1970, infestations intensified from these focal points. Detection surveys in 1974 indicated epidemic conditions on approximately 1,874 ha with a new epicenter between Camas and

Dutch Ridges (McGregor *et al.* 1975). In 1975 a total of 6,242 ha had light (25 trees/ha) to very heavy (74 trees/ha) infestation, and in 1976 the infestation encompassed 40,419 ha (Figure 1).

The frequency of epidemics appears to be directly related to site quality, with trees on better sites becoming susceptible more rapidly than those on poorer sites. Frequency and intensity of beetle epidemics are related to age, diameter distribution within the stand, phloem thickness, and elevation and latitude of the stand (Amman *et al.* In Press).

Infestations of the beetle seldom develop in stands less than 60 years of age. In stands 60-80 years old, a large proportion of trees are reaching diameters conducive to beetle infestation. Stands greater than 80 years old present the greatest potential for a beetle infestation.

The mountain pine beetle kills proportionately more large than small diameter trees during an infestation and, on the average, kills the largest diameter trees during each successive year of a major infestation. Larger trees generally have thicker phloem, which is directly related to beetle production, resulting in more beetles being produced in thick than in thin phloem trees. Beetle production is less in trees of dense stands, which usually have thinner bark and phloem. As larger diameter trees (20 cm d.b.h. and larger) containing thick phloem (0.25 cm thick) are killed by the beetle, infestations begin to decline (Amman *et al.* In Press).

To obtain estimates of number of infested trees per hectare, size of attacked trees, and overall infestation trend, ground surveys were conducted in the Quartz, Bowman, and Camas Creek drainages during November 1976.

METHODS

Estimates of number of infested trees/hectare were based on forty ¼-acre (0.10 ha) plots located at 5-chain (100 m) intervals in three infested drainages. A hypsometer was used to determine trees to be tallied within plot boundaries. Each infested tree 13 cm d.b.h. (diameter at breast height) and larger was recorded by d.b.h. and categorized into one of the following classes:

0 = Green, uninfested
1 = 1976 attack; green or partially faded foliage, brood in cambium, blue stain present.
2 = 1975 attack; red foliage, brood emerged.
3 = 1974 or prior attack; majority of needles dropped.
4 = Unsuccessful attack or pitchout; green foliage, pitchtubes present, brood and blue stain absent.

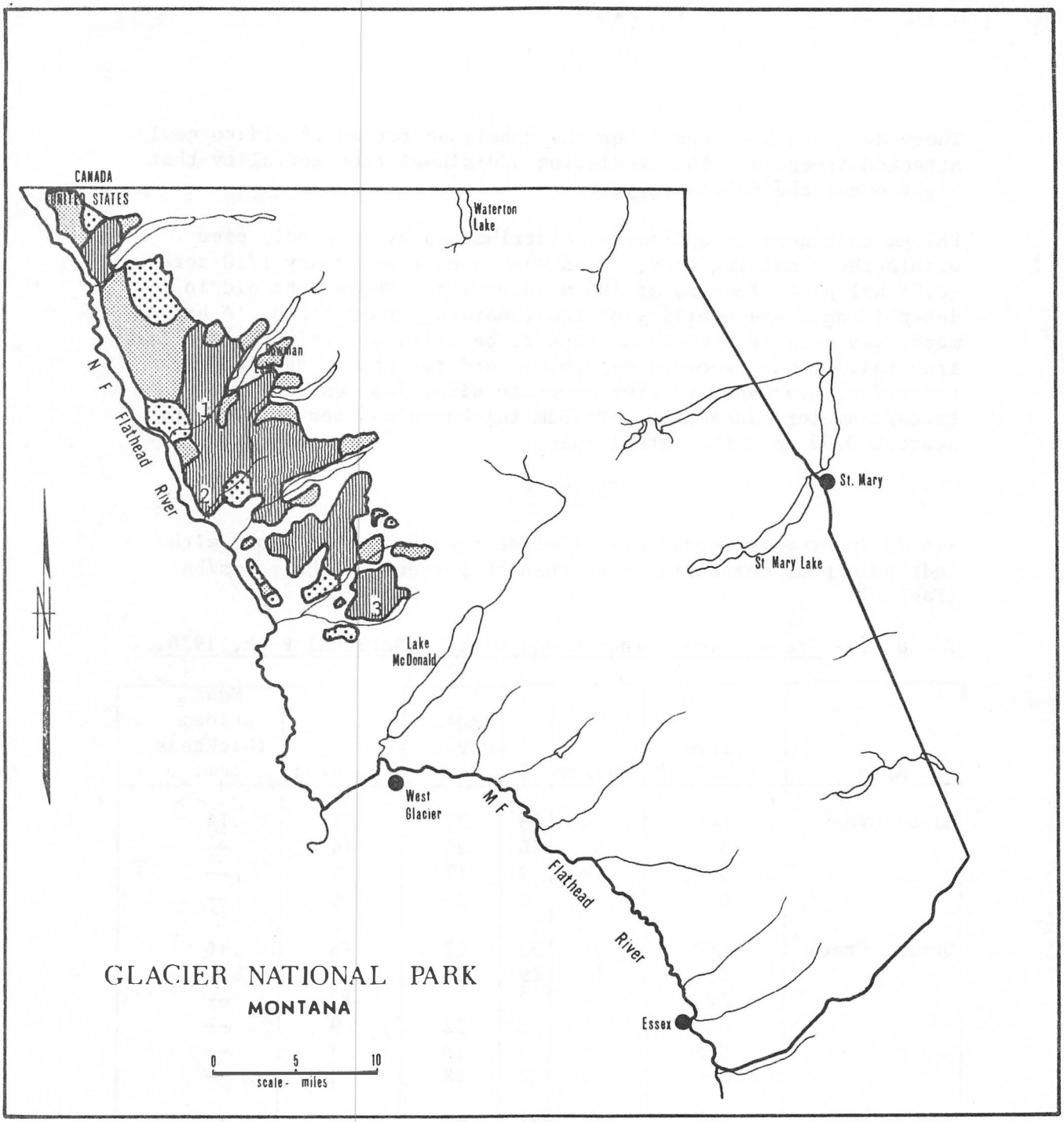

Figure 1.--Mountain pine beetle infestation, Glacier National Park, 1976

Infestation levels

Low

Medium

Heavy to very heavy

1 - Bowman Creek

2 - Quartz Creek

3 - Camas Creek

These data are used for determining buildup ratios of old to newly attacked trees, and for predicting additional tree mortality that might occur the following year.

Phloem thickness tree diameter distribution of lodgepole pine within the remaining green stand was taken from twenty 1/10-acre (0.04 ha) plots located at 100 m intervals. These data aid in determining susceptibility of the remaining green stand. A hypsometer was used to determine trees to be tallied within plots. Each tree tallied was recorded by d.b.h.; and two phloem samples were removed with a hand axe from opposite sides from each of two trees/diameter class/plot. Phloem thickness was measured to the nearest 0.02 cm with a steel ruler.

RESULTS

Stands in areas surveyed are of mixed species composition, with lodgepole pine comprising more than 50 percent of the stems/ha (Table 1).

Table 1.-- Green stand composition, Glacier National Park, 1976.

Area	Tree species*	Number	%	Mean d.b.h. (cm)	Trees/ha	Mean phloem thickness (cm)
Camas Creek	LPP	54	53	27	167	.14
	S	39	36	24	114	--
	SAF	9	9	17	28	--
	L	2	2	25	6	--
Quartz Creek	LPP	31	55	23	96	.16
	S	16	29	20	49	--
	DF	4	7	28	12	--
	L	3	5	32	9	--
	SAF	1	2	18	3	--
	PP	1	2	48	3	--
Bowman Creek	LPP	47	74	23	232	.17
	S	8	13	22	39	--
	DF	8	13	19	39	--

*Tree species: LPP, lodgepole pine; S, spruce; SAF, subalpine fir; L, larch; DF, Douglas-fir; PP, ponderosa pine.

Numbers of trees infested in 1976 ranged from a low of 52 per ha in Camas Creek to 125 and 169 per ha in Quartz and Bowman Creek drainages respectively (Table 2).

Table 2.-- Summary of infested stands surveyed, Glacier National Park, 1976.

Area	Infested trees/ha	Mean d.b.h. of attacked trees (cm)	Percent of phloem samples ≥ 0.25 cm	Buildup ratio from 1975
Camas Creek	52	29	20	1:1.5
Quartz Creek	125	28	20	1:2.1
Bowman Creek	169	26	28	1:3.1

Buildup ratios of old (1975) to newly attacked (1976) trees ranged from 1:1.5 in Camas Creek to 1:3.1 in Bowman Creek. Mean buildup ratio for all areas surveyed was 1:2.2. Tree mortality in 1976 occurred in all diameter classes from 13 to 51 cm with greatest mortality in the 18 to 33 cm d.b.h. classes.

Approximately 23 percent of the trees attacked in 1976 had a mean phloem thickness ≥0.25 cm. Mean diameter of the remaining uninfested lodgepole pine stand is approximately 24 cm with a mean phloem thickness of 0.16 cm.

DISCUSSION

The current mountain pine beetle infestation has caused considerable loss of lodgepole pine in Glacier National Park. The outbreak began increasing in 1970 and increased through 1976. Infested acreages and numbers of newly attacked trees increased through 1972, decreased in 1973, then increased sharply from 1974 through 1976. The current buildup ratio of 1:2.2 is a decrease from the 1:10 ratio from 1973 to 1974. Although it indicates a decline, sufficient beetle populations and lodgepole pine are available to continue the epidemic.

Approximately 40,419 ha are currently infested. Of this, heavy to very heavy infestation occurs on 21,638 ha. Moderate infestation occurs on 12,274 ha and scattered single trees occur on 6,507 ha. Based on buildup ratios from 1972 to 1976, and on the formula $y'=y+bx$ (Baker, 1968) where

y' = the potential cumulative number of trees killed predicted through next year (1977).

y = the cumulative number of trees killed through this year.
x = number of trees killed this year (1976).
x_1 = number of trees killed last year (1975).
$b = \frac{x}{x_1}$

it is predicted that nearly 3 million trees will be killed in areas of heavy to very heavy infestation in Glacier National Park through 1977.

Infested area may increase and degrees of infestation intensity are expected to change. For example, areas of current low infestation intensity along Starvation, Ford, Parke, Bowman, and Dutch Creeks can be expected to become moderate while areas of moderate infestation along Kishenehn, Mud, and Akokala Creeks infestations may increase to heavy or very heavy levels.

The current infestation in Glacier National Park is expected to continue at epidemic levels until the food source is depleted. As larger diameter trees are killed and beetles move to smaller trees with thinner phloem, fewer and smaller beetles will be produced (Safranyik and Jahren 1970). Thus the infestation should decline. However, with the large volume of lodgepole pine available, this infestation could continue at epidemic levels for another decade or more.

We do not recommend applied management of the infestation because (1) silvicultural stand management is not permitted under NPS policy, and (2) chemical treatment would be costly and probably ineffective considering the magnitude of the problem. Park Service policy states that "native insects and diseases existing under natural conditions are natural elements of the ecosystem. Accordingly, populations of native insects and the incidence of native diseases will be allowed to function unimpeded except where management is required (1) to prevent the loss of the host or host-dependent species from the ecosystem; (2) to prevent outbreaks of the insect or disease from spreading to forests, trees, other vegetative or animal populations outside of the area where possible; (3) to conserve threatened, endangered or scientifically valuable specimen plants or unique plant communities, or (4) for reasons of public health or safety."

Beetles from infested trees have spread to susceptible lodgepole pine stands on the adjacent North Fork Flathead River drainage, Flathead National Forest. Approximately 505 ha are now infested at epidemic level. The infestation appears to be progressing southward. Because of this southward movement, there is a potential

threat of lodgepole pine stands containing trees 20 cm d.b.h. and larger becoming infested in the Middle Fork Flathead River drainage, Flathead National Forest. These stands are directly south of Glacier National Park and contain approximately 12,950 ha of susceptible lodgepole pine sawtimber.

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